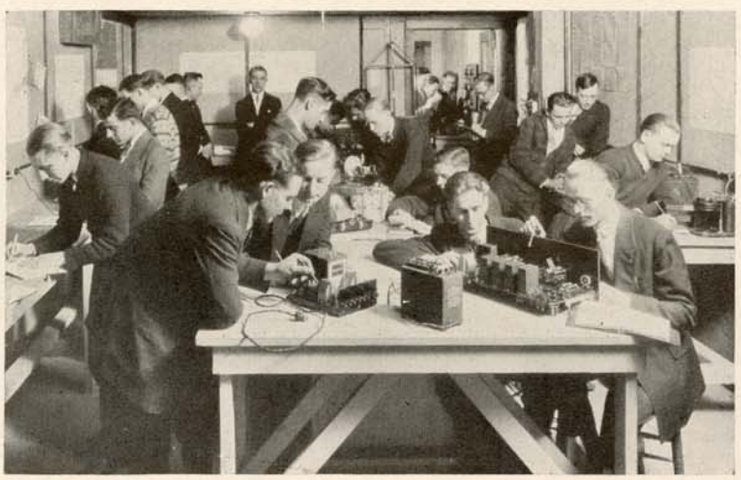
A Practical Radio Course In Three Months

THE School of Engineering has included instruction dealing with the science of wireless communication in its courses for many years. It was one of the pioneers in this particular phase of Electrical Engineering.

In the years of 1919 and 1920, the development of the vacuum tube broadened the field of radio telephony enormously. This important addition to the knowledge of wireless communication caused the science to develop most rapidly, and the ever-increasing popular and commercial demand for efficient radio apparatus taxed the ability of the country's finest engineers.

The policy of S. of E., ever since its inception, has been to improve and to enlarge the scope of its courses to meet the needs of the electrical industry. Accordingly, a complete course in Radio was included in the school's curriculum, when it became evident that radio had come to stay; that it had passed its experimental stages and was rapidly becoming a vital factor in the industrial and economic affairs of the entire civilized world.

In outlining the course, particular stress has been laid upon the immense value of practical laboratory work. The principles learned in the classroom are most strongly impressed upon the student through the medium of practical work. S. of E. students "learn by doing."



S. of E. Students learn by doing. A general view of one of the Radio Laboratories

The radio laboratory is particularly well equipped, and every effort has been made to secure the most modern apparatus and to keep the equipment up-to-date. In addition to this unusual opportunity to secure practical instruction, the students have the advantage of being in close contact with the 500-watt station WISN (formerly WSOE) and the amateur station 9SO, both of which are owned and operated by the school.

Some of the first laboratory problems deal with the fundamentals of electricity. It is necessary that the trained radio expert be familiar with electrical tests, and so instruction is given in the measurement of electrical resistance by several methods; the use of the galvanometer; the measurement and calculation of condenser capacity, etc. Since magnetism plays an important part in the radio circuit, several experiments in magnetic phenomena are performed by the student. These include the mapping of magnetic fields, the magnetic effect of current carrying wires, and other experiments of a similar nature.

The condenser is one of the most important pieces of apparatus entering into the construction of radio transmitting and receiving equipment. Its capacity, and therefore its effectiveness in the radio circuit, is determined largely by the dielectric used. Therefore, the S. of E. student tests the various materials commonly used as dielectrics and determines their relative values.

Another interesting phase of the laboratory work is the study of the various types of radio antennae. The student learns through experiment, the comparative values of each type, the advantages and disadvantages, the directional effects, methods of protection against lightning, etc.

Practical instruction in the methods of building and repairing receiving and transmission sets forms an important part of the laboratory work. The first problems in construction deal with the soldering and splicing of wire; the use of soldering equipment and the methods of making the various soldered joints used in radio equipment. After having completed these preliminary problems in construction, the student learns to lay out panels and is instructed in the most approved methods of mounting the apparatus. Many radio receiving sets do not operate satisfactorily, simply for the reason that the equipment is not properly mounted, and that the separate pieces of apparatus do not bear the proper relation to each other.

The vacuum tube is the piece of apparatus to which we owe the phenomenal development of radio communication. To learn thoroughly the principle of the vacuum tube; the determination of filament and plate saturation curves is essential to the student who wishes to master the fundamental principles of radio. The characteristics of vacuum tubes are therefore studied in detail. Special testing apparatus is available in the laboratory for this purpose.

In addition to the laboratory tests previously described, a thorough study is made of the various radio circuits, such as the regenerative and non- regenerative circuits, the neutrodyne and super-heterodyne circuits, and others. These circuits are constructed, tested and operated by each student.

The technical lectures are amply supplemented with work relating to the sales and merchandising phases of the radio industry. S. of E. not only offers a complete course in the technique of radio, but it also teaches a student the economics of the subject by giving instruction in the methods of building a successful business.

A Brief Outline of the Course

The Principles of Radio Reception, Radio Transmission and the Design and Building of Equipment are Thoroughly Covered

I. ELEMENTS OF ELECTRICITY

Theory of direct currents; Ohm's law; Units of measurement: the volt, ampere, ohm, coulomb and watt; Simple electrical circuits; Application of Ohm's law to series and parallel circuits; Resistance measurements: the volt-ammeter, comparison and Wheatstone bridge methods; Wire calculations; Conductors and non-conductors.

Magnetism: Definition of magnetic field; Types of magnets; Electromagnetism; Magnetic field about a coil; Magnetomotive force; Permeability; Application of magnetism to radio.

A. C. theory: Inductance; its cause and effect; its relation to the radio circuit; calculation and measurement; Effect of capacity in A. C. circuits; Series and parallel connection of capacities and calculations; Frequency and wave lengths—definitions and calculations; Fundamentals and harmonics; Condenser dielectrics.

II. ANTENNAE AND THEIR INSTALLATION

Types of antennae; Uses; National Board of Fire Underwriters' Code Regulations; Wave propagation and reception; Antennae construction and installation; Antennae characteristics; Directional effect; Grounds; Loops, Counterpoise; Lightning arresters.

A Radio Laboratory Class at S. of E.

III. MEASURING INSTRUMENTS

D. C. Voltmeters and ammeters; Ampere-hour and wattmeters; A. C. meters; Hot wire and thermocouple instruments; Application of instruments to radio use; Meter testing and calibration; Changes of meter ranges; Use of ammeter shunts and voltmeter multipliers.

IV. SIMPLE CIRCUITS AND CRYSTAL DETECTORS

Construction of simple circuits; Telephone analogy; Operation and uses; Type of single tube receivers; Troubles and their correction; Methods of tuning; Crystal detectors; Detector action; Crystal receivers.

V. RADIO TUBES

The electron theory as applied to the vacuum tube; Electronic emission; Atomic structure; Thermionic action; Amplifier action; Detector action; Types of tubes, their construction and uses; Soft and hard tubes; Output impedance; Amplification constant; Determination of tube characteristics; Tube tests; Oscillations,—cause and effect; Regeneration; A. C. tubes; Shielded grid tubes.

VI. POWER SUPPLY

Primary and secondary batteries—uses and construction; Chemical reactions; Determination of internal resistance; Effect of internal resistance upon performance; Preparation of solutions; Specific gravity; Determination of charge and discharge rates; Battery maintenance and repair; The Edison battery; Battery chargers; Types, construction, repair; Battery eliminators—"A" and "B" types; Principles of eliminator operation; Construction of filter circuits and their application to battery eliminators; Electrolytic condensers; "Brute force" filters; Chemical rectifiers; Common troubles in charging and eliminator equipment and remedies.

VII. AUDIO FREQUENCY AMPLIFICATION

Definition of "audio frequency"; Audio amplification as applied to radio circuits; Coupling devices; Transformers, resistance and inductances; Push-pull circuits and their advantages and disadvantages; Adaptation to tube circuits; Amplifier construction; Tests and repairs; Power amplifiers; Definition, construction, uses and common troubles; Phonograph "pick-up" devices.

VIII. RADIO FREQUENCY AMPLIFICATION

Definition and application to radio; Types of coupling; Regeneration and oscillation; Types of control: Potentiometer, tickler control, balancing neutrodyne method, bridge methods; Eddy currents; Amplification with various coupling devices; Design and construction of radio frequency amplifiers; Troubles and their remedies; Matching coils; Effects of distributed capacity upon tuning; Shielding.

IX. THE SUPER-HETERODYNE

Principle of super-heterodyne circuit; Beat principle; Various types of circuits; Operation; Matching intermediate transformers; Harmonics; Layout, assembly and wiring; Troubles and remedies; Standard makes.

X. A. C. SETS

Elementary principles; Types of A. C. sets; Diagnosis of troubles; "A. C. hum"; Laboratory problems on standard sets such as Atwater-Kent, Kellogg, R. C. A., etc.

Thorough Practical Training

XI. HISTORY OF RADIO

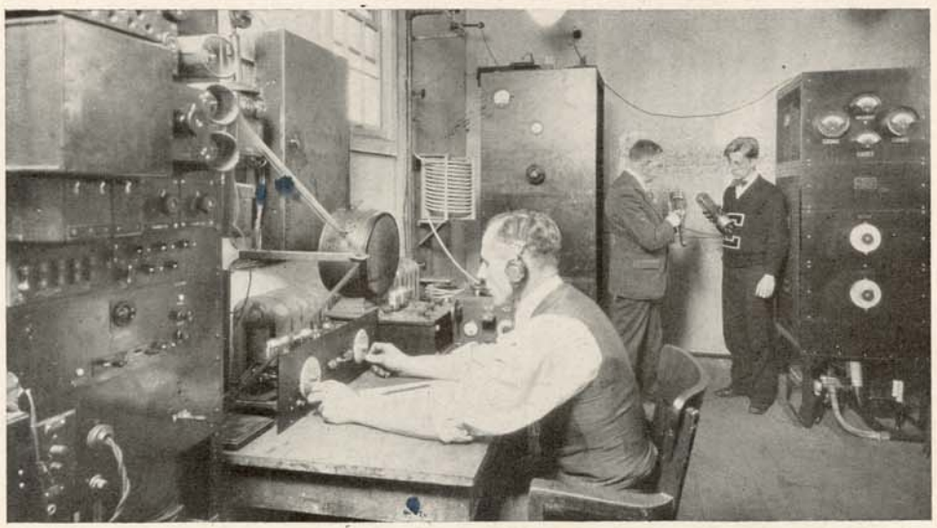
Early electrical discoveries leading to radio; The scope of the industry; The Radio Engineer in industry; Standardization; Books, magazines and pamphlets as guides; Clubs, societies and trade organizations.

XII. SET BUILDING

Construction of representative set from each of the main types of receivers; Regenerative, non-regenerative, tuned radio frequency, neutrodyne and superheterodyne sets; Coil design and construction; Panel and baseboard layouts; Circuit and wiring diagrams; Blueprint reading; Precautions to observe in layout; Mechanical construction.

XIII. SERVICE, REPAIR AND TESTING

Commercial tests of batteries, tubes, antenna systems and loudspeakers; Circuit tests of transformers, condensers; Converting sets for A. C. operation; Test kit contruction and use; Tests of various commercial types of receivers; Locating trouble; Characteristics of each types of receiver, their troubles and remedies; Service of phonograph motors in combination sets; Duties of a service man; Methods used by "radio doctor"; Shop management and layout; Records; Shop methods of testing and repair.



Transmitting room of the S. of E. station, WISN.

XIV. MODERN APPLICATIONS OF RADIO

Principles of Television; Fractional wattage tubes; Direction finders as applied to ships; Depth finders, Location of ore deposits; Radio beam compass as applied to airways, airplanes and airports; Control of various mechanisms by radio; Broadcast chain relay stations; Trans-oceanic radiophone; London-New York system; Radio compass stations; Wired wireless; Piezo crystals; Power transmission; Moore and Coolidge tubes; Photo-Electric cell; Cathode ray oscillograph.

XV. WAVEMETERS AND OSCILLATORS—INTERFERENCE

Construction and use of wavemeters and oscillators; Methods of checking equipment through their use; Dead spots; Static interference; Effect of stray fields; Faulty wiring; Effects of faulty electrical appliances; Effect of motors, X-Ray machines, vibratory rectifiers and violet ray machines upon operation of radio equipment; Location of interference and remedies.

This work is especially valuable to the serviceman who will often find that suspected troubles in radio equipment are really the effects of some form of local interference.

XVI. TRANSMITTING SETS

Fundamentals of transmitting; The vacuum tube transmitter; Various types of circuits used; C. W. and phone transmitters; Grid and plate modulation; Piezo crystal control; Side bands; Microphone construction and use; General transmitting information; Short waves; Adaptation of equipment to aircraft; Laboratory exercises in amateur station 9SO; Code instruction and practice; Power panels; Decrement; Commercial spark transmitters and receivers; Beam transmission, Laws governing radio communication.

In this section of the course students are trained to pass the U. S. Government examination for the commercial operator's license.

XVII. SALES AND MERCHANDISING

Selection of location; The downtown store; The neighborhood store; Financing; Selection of a well-balanced stock; Attracting trade; Advertising; Direct mail solicitation; Special sales; House-to-house selling; Following prospects; Installment plan sales; Demonstrations; Store methods; Accounting systems; Store operating costs; Expanding the market; Interesting buyers; Reaching the farm market; Wired outlets in hospitals, hotels and homes; School installations; Dealers' responsibility to purchaser; Trade-ins; Joining trade organizations; Allied lines of merchandise to overcome seasonal slumps.

XVIII. BROADCASTING

Engineering principles; Arrangement of programs; Announcing; Organization and management; Radio advertising; Studio management; Chain broadcasting.

XIX. RADIO DESIGN

Design of coils, condensers, transformers, complete receiving sets and accessories; Practical problems and laboratory exercises.

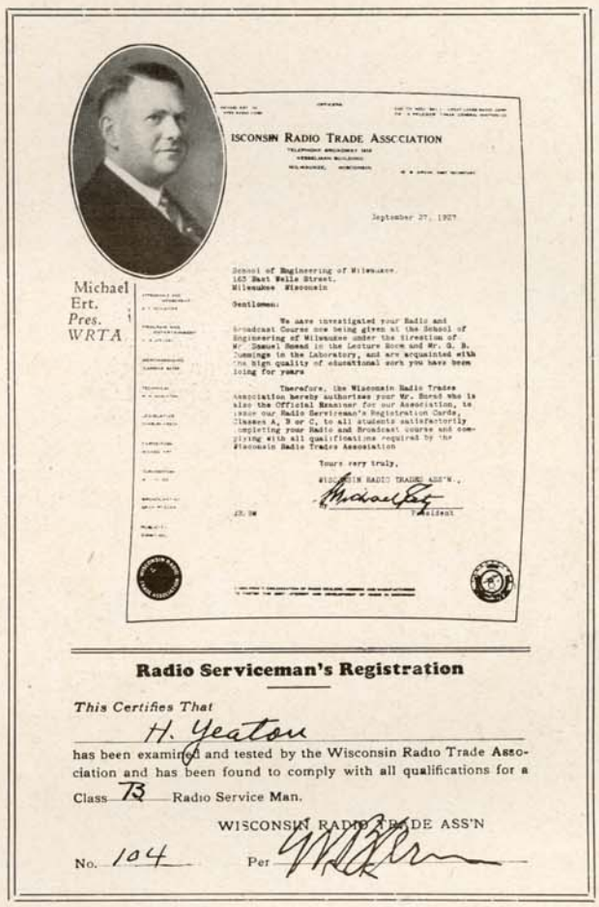
Students pursuing the radio course learn to completely design radio receiving equipment. This includes the preliminary layout of the apparatus shown by means of sketches, the design of transformers, condensers, etc. The construction of the important types of receivers is carried on by each student in the laboratory. The laboratory work also includes the tests which are applied to defective radio equipment.

In the latter part of the course the Radio classes make inspection trips to large broadcasting stations in Chicago and Milwaukee. The classes also visit manufacturing plants, where they have an opportunity to study the production methods for radio equipment.

S. of E. Course is Endorsed by Wisconsin Radio Trades Association

THE fact that the three month radio course has earned the endorsement of the Wisconsin Radio Trade Association means much to the S. of E. graduate. This well known radio organization has carefully investigated the school, highly approves of it and endorses the radio course it offers. The Wisconsin Radio Trade Association will issue servicemen's Registration Cards to all S. of E. students who successfully complete the course.

Employers of radio servicemen know that a man who has gained such recognition is competent and thoroughly qualified to hold a trustworthy position in the radio industry. The Registration Card carries with it a prestige which is extremely valuable in any state of the Union. It is written evidence that its bearer has successfully completed a period of thorough training and that he has complied with the most rigid requirements of the Wisconsin Radio Trades Association.



Michael Ert. *Pres. WRTA*

ISCONSIN RADIO TRADE ASSCIATION

September 27, 1927

School of Engineering of Milwaukee.
165 East Wells Street.
Milwaukee Wisconsin

Gentlemen:

We have investigated your Radio and Broadcast Course now being given at the School of Engineering of Milwaukee under the direction of Mr. Samuel Sneed in the Lecture Room and Mr. G. B. Cummings in the Laboratory, and are acquainted with the high quality of educational work you have been doing for years

Therefore, the Wisconsin Radio Trades Association hereby authorizes your Mr. Sneed who is also the Official Examiner for our Association, to issue our Radio Serviceman's Registration Cards, Classes A, B or C, to all students satisfactorily completing your Radio and Broadcast course and complying with all qualifications required by the Wisconsin Radio Trades Association

Yours very truly,

WISCONSIN RADIO TRADE ASS'N.,

President

Radio Serviceman's Registration

This Certifies That

H. Yeaton

has been examined and tested by the Wisconsin Radio Trade Association and has been found to comply with all qualifications for a Class B Radio Service Man.

WISCONSIN RADIO TRADE ASS'N

No. 104 Per

Radio Communication Spreading to New Fields

Radio is entering into almost every field of human endeavor. Today we must have operators for ships' radios; and they must be good men, for often the fate of the vessel and its passengers depends upon the radio operator. On land, trains, interurban lines, motor busses, are now being dispatched by radio messages. Many transcontinental trains already carry receiving equipment, and passengers are able to enjoy radio programs to break the monotony of a long journey. In the future, perhaps the telegraph instruments now in every railroad station in the country will be replaced by radio receivers.

Many Uses for the Radio Principle

So many uses for the vacuum tube are being found with such startling rapidity that we are left almost to gasp at the incomprehensible power of this little glass bulb.

A new field has been opened up in scientific research. Feeble electric currents can now be amplified through vacuum tubes so that they are easily measurable by ordinary instruments. Gear noises and friction are but a few of the things now detected in this manner. Within late years the same vacuum tube principle has been applied to long distance telephony and has made possible great advances in this phase of electrical engineering.

Private Broadcasting Stations

Many large electrical power companies have already installed radio apparatus to communicate with sub-stations forming part of a power plant net-work where formerly the telephone was used exclusively.

In aviation, radio also plays a vital part. Many of our airports are equipped with sending and receiving stations by means of which communication may be held with approaching planes. The aviators are radio-advised of weather conditions, of the direction of prevailing winds, and the height of cloud banks, etc., to enable them to make a safe landing.

Recently large business organizations have installed radio equipment for communicating with branch offices and factories. The possibilities of this particular application of radio are unlimited and within a few years, many important affairs will be conducted over the private radio. Apparatus for the transmission of electrical power by radio is now in its experimental stage. Engineers have succeeded in transmitting appreciable amounts of electrical power by radio, and some day power lines will be a thing of the past.

The Achievement of Television

Great advances have been made in the development of Television. We have already seen Television demonstrated, and soon, you, too, will be able to see the singer or speaker broadcasting a program. You will see the stage setting for an opera or musical comedy and enjoy the whole performance in your own home. Applied to the newspaper, Telephotography has worked wonders. Pictures of events occurring in European capitals in the morning will appear in the afternoon editions of our American newspapers.

Television apparatus will soon be put on the market at a price that any radio owner can afford to pay. Think of the great, wide field this will open in manufacturing, sales, and service! Thousands of trained men will be needed to install and service Television sets.

But think, too, of the unlimited fields now open in the other forms of radio application! In a few more years the uses of radio will double—yes, perhaps treble.

Here, then, are opportunities for the radio-trained man to exceed even your fondest dreams. No longer can the young man of today say: "There is no opportunity."

Great Opportunities in Radio

You can win your place in the radio world with the proper kind of training and initiative. Radio needs you; and through the School of Engineering of Milwaukee, one of the oldest electrical institutions in the country, you can prepare yourself to enter whatever phase of the Radio Industry appeals to you most—as a full-fledged, experienced and practical man.